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DESIGN, DEVELOPMENT, TEST, AND EVALUATION OF A 50-GPM OPTIMUM LIGHTWEIGHT FILTER/SEPARATOR

by

George A. Gariepy

Code 1

March 1966

U. S. ARMY ENGINEER RESEARCH AND DEVELOPMENT LABORATORIES
FORT BELVOIR, VIRGINIA

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Task 1M643324D59209

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FOREWORD

Design, development, test, and evaluation of a 50-gpm, optimum lightweight filter/separator was conducted under the general authority of Project 1M643324D592, "Fuel Handling Equipment." The work was accomplished in accordance with the specific requirements of Task 1M643324-D59209, "Fuels Decontamination Equipment." A copy of the Research and Technology Resume is included as the appendix to this report.

The period covered by this report is from July 1964 to October 1965.

The development project was carried on under the general supervision of L. L. Stark, Chief, Fuels Decontamination Branch, Petroleum Equipment Division, Mechanical Department. George A. Gariepy was Project Engineer. Participating test area personnel who operated the test facilities and conducted the required evaluation tests were: Melvin J. Albright, Test Leadman; and Lloyd R. Johnson and L. Mitchell, Test Mechanics.

SUMMARY

This report covers design, development, test, and evaluation of a 50-gpm optimum, lightweight filter/separator for primary application with 50-gpm standard Military bulk transfer pumps.

A preliminary design was prepared, and a contract was awarded for fabrication of a prototype model. Test and evaluation of this unit indicated the preliminary design was satisfactory. Therefore, six developmental test models were procured from Bowser-Briggs Filtration Division, Cookeville, Tennessee, and subjected to the comprehensive evaluations necessary to determine conformance to the water- and solids-removal performance requirements of Military Specification MIL-F-8901A. In addition, rail impact and rough handling tests were conducted. The report concludes:

a. The 50-gpm optimum, lightweight filter/separator, when tested under conditions specified in MIL-F-8901A, meets all established water- and solids-removal performance requirements.

b. All requirements of the Small Development Requirement (SDR) are met except the requirement for incorporation of the "Go-No Go" gage device. An exception is taken because it is concluded that the stated requirement is unrealistic and that it is an unnecessary refinement which would increase the size, weight, and cost of the filter/separator.

c. The filter/separator, without further modification, is suitable for integrated engineering and service tests.

CONTENTS

Section	Title	Page
	FOREWORD	ii
	SUMMARY	iii
I	INTRODUCTION	
	1. Subject	1
	2. Background	1
	3. Design Criteria	2
	4. Prototype Fabrication	5
	5. Application, Description, and Function	6
	6. Studies Performed during Development	14
II	DEVELOPMENTAL EVALUATION TESTS	
	7. Performance Requirements	15
	8. Test Facilities	15
	9. Test Fuel and Contaminants	17
	10. Sample Analysis Procedures	18
	11. Test Procedures and Results	18
III	DISCUSSION	
	12. Conformance to Design Criteria	28
	13. Exception Taken to SDR	31
	14. Status of Procurement Data	31
	15. Estimated Production Costs	32
IV	CONCLUSIONS	
	16. Conclusions	32
	APPENDIX	33

ILLUSTRATIONS

Figure	Title	Page
1	Assembled Developmental Model of 50-GPM, Optimum, Lightweight, Filter/Separator	8
2	Interior of Filter/Separator Showing Manifold	9
3	Side of Filter/Separator Showing Pressure Differential Indicator and Decal Instructions	10
4	Interior of Filter/Separator Showing Canister and Elements	11
5	Filter/Separator Inlet Showing Installation of Flow Limiter	12
6	Pressure Differential vs Flow Rate Characteristic Curve for Flow Limiter	13
7	Pressure Differential vs Flow Rate Characteristics of Optimum, Lightweight Filter/Separator during Pressure Drop Test	21
8	Pressure Differential vs Time Characteristics of Filter/Separator during Water-Removal Tests	23
9	Pressure Differential vs Time Characteristics of Filter/Separator during Solids- and Water-Solids Removal Tests	25
10	Typical Impact Speed vs Shock Force Characteristics during Rail Impact Test	27

DESIGN, DEVELOPMENT, TEST, AND EVALUATION OF A 50-GPM OPTIMUM LIGHTWEIGHT FILTER/SEPARATOR

I. INTRODUCTION

1. Subject. This report covers design, development, test, and evaluation of a 50-gpm optimum lightweight filter/separator required for use in decontaminating military liquid hydrocarbon fuels.

2. Background. In a move toward providing complete assurance that only clean dry fuel will be delivered to military aircraft, equipment, and vehicles, the Department of Defense (DOD) published controlling Specification MIL-F-8901, 14 February 1961, entitled "Filter/Separators, Aviation and Motor Fuel, Ground and Shipboard Use, Performance Requirements and Test Procedures For." The degree of water and solids removal required by this specification was much more rigorous than were previous requirements. None of the commercially available decontamination equipment used by the military services up to that time was able to meet the new requirements. A further disadvantage of the commercial equipment was that it completely lacked interchangeability of component parts. This situation resulted in serious procurement, training, operational, maintenance, and parts replacement problems. It was therefore determined that a family of military design filter/separators would be developed, to include a range of flow capacities that would meet all then known military requirements. The first step was development and evaluation of a standard size expendable-type filter/coalescer element, capable of meeting the new rigorous performance requirements of MIL-F-8901 at a flow rate of $12\frac{1}{2}$ gpm, and suitable for use in multiples in each size filter/separator of the military group. Development of this basic family of filter/separators has been completed. The work has been covered in USAERDL Technical Report 1716-TR, 29 June 1962. Requirements for still smaller and lighter filter/separators which would be suitable for use in systems being developed to support the concept of highly mobile, quickly dispersible military forces became evident at this time. Subsequent efforts to upgrade the performance of the filter coalescer elements were successful. The technical feasibility of increasing the flow rate to 20 gpm per element which was indicated would permit a major reduction in overall filter separator size and weight. To support the development, USAERDL prepared a preliminary draft, Small Development Requirement (SDR), in March 1963, entitled "Family of Optimum Performance, Compact, Lightweight Filter Separators, 50, 300, and 600 GPM Flow Rates," and submitted it to Combat Development Command

(CDC) Engineer Agency for staffing. * Limitations of funds and personnel prevented concurrent development of the three separators included in the SDR. This report covers design, development, and evaluations of the 50-gpm size.

3. Design Criteria. Basic design criteria and priority of technical characteristics, as extracted from the SDR, follow:

a. Operational.

(1) ESSENTIAL - Be capable of performing satisfactorily within the environmental requirements as defined in pars. 7a, b, and c of AR 705-15, with Change 1, "Operation of Materiel Under Extreme Conditions of Environment," except for expendable interior components, for a period of 5 years.

(2) ESSENTIAL - Shall satisfactorily process all military aircraft and vehicle fuels at the prescribed flow rates.

(3) ESSENTIAL - Shall decontaminate fuel to the cleanliness standards delineated in MIL-F-8901.

(4) ESSENTIAL - Shall meet the requirements of MIL-F-8901 on both an intermittent and continuous flow basis.

(5) ESSENTIAL - Shall continue to perform satisfactorily when subjected to pressure surges resulting from supply pump start and stop.

(6) ESSENTIAL - Shall be of a design requiring a minimum of welding, forging, machine work or other scarce wartime skill.

(7) ESSENTIAL - Shall be of such configuration that it presents a low silhouette and has a low center of gravity.

(8) ESSENTIAL - Shall be sufficiently rugged to withstand shocks and vibrations normal to military transportation.

* CDC draft, May 1964, is currently being used for guidance by the developing agency.

(9) ESSENTIAL - Shall be constructed so that it can be operated easily by trained troops or civilians.

(10) ESSENTIAL - Shall be capable of being operated without hazard to operating personnel.

(11) ESSENTIAL - Shall be as immune to enemy radiological, chemical, and biological operations as related fuel equipment.

(12) Shall not exceed the following dimensions and weight (filter/separator pressure vessel):

	Height	Diameter	Weight (Dry)
ESSENTIAL	32 in.	14 in.	36 lb
DESIRED	29 in.	12 in.	34 lb

When the filter/separator is mounted in a tubular frame for portable application, its overall dimensions and weight as shown here shall not be exceeded:

	Height	Width	Length	Weight (Dry)
ESSENTIAL	34 in.	16 in.	20 in.	60 lb
DESIRED	32 in.	15 in.	18 in.	50 lb

(13) Servicing Time. Predicted servicing time is 2 hours assuming no repairs are required. Servicing time is the time to service and check out the filter/separator unit for recommitment to include removing old filter/coalescer elements and installing new elements, if needed.

(14) Reaction Time. Reaction time, the time for fuel to pass through the filter/separator, is not to exceed 15 seconds.

(15) Mission Reliability. (ESSENTIAL) Reliability shall be 90 percent for a mission time for 15 hours. (DESIRED) Reliability shall be 98 percent for a mission time of 15 hours.

(16) Combat-Ready Rate. After the specified equipment reaction time, the filter/separator must be capable of instantaneous employment. A combat-ready rate or availability readiness rate of 97 percent will be required.

b. Maintenance.

(1) ESSENTIAL - The filter/separator shall be designed to require a minimum of operation in-storage maintenance.

(2) ESSENTIAL - The design shall require a minimum number of man-hours and skills to accomplish necessary maintenance.

(3) ESSENTIAL - The filter/separator shall utilize modules to accomplish repair by replacement, where feasible.

(4) ESSENTIAL - Standard components and accessories shall be used insofar as practicable.

(5) ESSENTIAL - All components shall be designed to permit ease of access for inspection and maintenance.

(6) ESSENTIAL - Fragile components shall be armored or guarded to minimize incidence of breakage.

(7) ESSENTIAL - Total scheduled and unscheduled maintenance man-hours shall be a constant ratio, not to exceed 3 percent of the operational hours. Scheduled maintenance will be performed between missions.

(8) ESSENTIAL - The test and checkout methodology shall be as follows:

(a) Allowable time for diagnosing failures will be such that 95 percent of the diagnoses will be accomplished as follows:

1. Organizational unscheduled maintenance--5 minutes

2. Direct support unscheduled maintenance--5 minutes

(b) Allowable time for making repairs will be such that 95 percent of the activities will be accomplished as follows:

1. Organizational unscheduled maintenance--2 man-hours

2. Direct support unscheduled maintenance--
6 man-hours

(9) ESSENTIAL - Shall possess simplicity in design so that the skill level required to operate and perform organizational maintenance will not exceed the skill level of MOS 552.1.

c. Priority of Technical Characteristics. In designing the 50-gpm filter/separator the technical characteristics used were given the following priorities, in the SDR in the order listed:

(1) Performance.

(2) Reliability.

(3) Weight.

(4) Transportability.

(5) Durability.

(6) Simplicity of Maintenance.

4. Prototype Fabrication. On the basis of the criteria just presented, a 50-gpm filter/separator design was evolved which utilized nine major subassemblies: (1) Vessel body; (2) removable head; (3) three canisters; (4) three standard military dimension filter/coalescer elements; (5) water drain valve; (6) water level sight glass; (7) pressure differential indicator; (8) protective frame; and (9) flow limiter. A prototype unit of this design was fabricated and subjected to preliminary performance evaluation at USAERDL to establish design suitability. Satisfactory results of this preliminary evaluation indicated feasibility of proceeding with procurement of a number of engineer design test (EDT) models. This procurement was initiated in November 1964, at which time invitations to bid were sent to fifteen potential manufacturers. Bowser-Briggs Filtration Division, Cookeville, Tennessee, was the successful bidder, and Contract DA-44-009-AMC-995(T) was awarded for six 50-gpm units to be fabricated in accordance with engineering drawings supplied by USAERDL. Prior to delivery, the filter/separators were inspected and hydrostatically tested at the manufacturer's plant. Delivery was made to USAERDL, Fort Belvoir, Virginia, in July 1965.

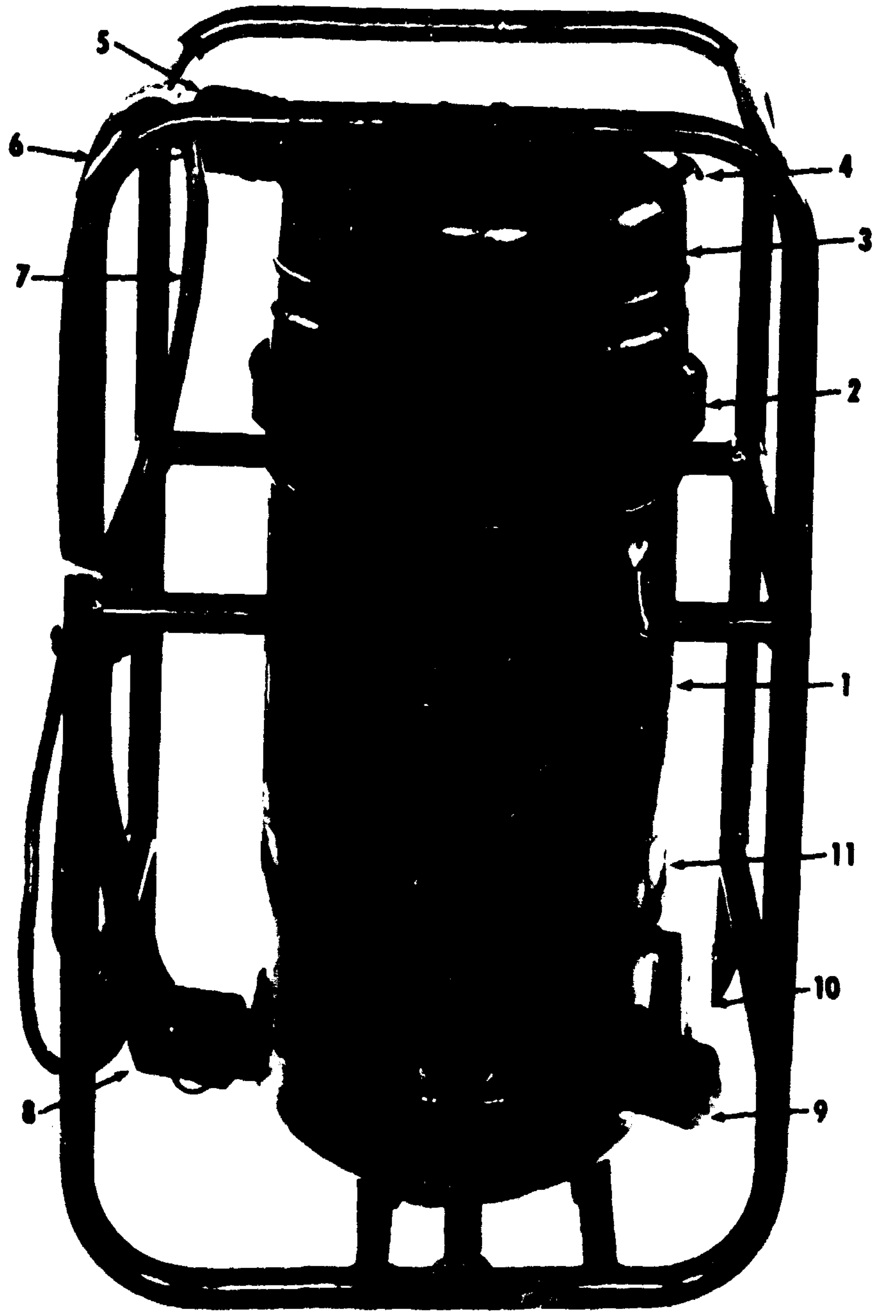
5. Application, Description, and Function. The primary application for the 50-gpm optimum lightweight filter/separator is as a major component of the 50-gpm bulk transfer pumping assembly covered by TM-10-1103, entitled Quartermaster Petroleum Handling Equipment. With the protective frame omitted, and other suitable mounting means provided, the device can also be used for either mobile or fixed applications. The filter/separator is fabricated almost entirely of aluminum alloy. The vessel body consists of a 12-inch-diameter cylinder, the bottom end of which is welded to a dished head and the top end of which is welded to a V-band flange that has an O-ring cavity. A removable cover is fabricated by welding a dished head, identical to the one at the vessel bottom, to a mating V-band flange. Inside the bottom dished head is welded a Y-shaped, combination inlet pipe and distribution manifold. Welded to the Y-shaped manifold are three riser pipes which serve several functions, namely: (1) Provide a sealing surface for one end of the filter/coalescer elements; (2) provide an element assembly stop; (3) feed the contaminated inlet fuel to the inside of the filter/coalescer element; and (4) have radially extending fingers which engage with grooves in the bottom skirt of the canister to retain and lock the element and canister in place. Mounting bosses are welded to lower portion of the vessel for the sight glass, the water drain valve, and the pressure differential indicator. A tube, welded to the mounting boss for the water drain valve, extends to the lowest point inside the dished head. This results in a siphon-type water drain line to prevent bursting the valve as a result of freezing. The canisters consist essentially of a 5-inch-diameter cylindrical perforated tube, the top end of which is welded to a disc or plate that has a sealing surface for the element, extending centrally into the cylinder. The open end of the cylinder is welded to an unperforated ring that has slots (cut axially into the ring) which receive the three locking fingers of the riser. A support ring is welded about 1/2 inch above the unperforated ring and forms a groove. Assembled in the groove is a wave-type spring washer. Inside the perforated tube is a cylinder of Teflon-coated 100-mesh monel screen. This screen is sealed along its longitudinal seam and around its circumference at each end. An outlet pipe nipple is welded to one side of the head, and a mounting nipple is welded to the opposite side to which is threaded an air release pet cock. The removable head is sealed to the vessel body by means of an O-ring and is retained by means of a V-band quick coupling.

Threaded on the outlet pipe is a male quick-disconnect coupling and dust cap. Assembled on the inside of the inlet pipe is a flow limiter. Threaded on the inlet pipe is a female quick-disconnect coupling.

The entire pressure vessel is contained and supported within a rectangular protective frame. Attached to the protective frame is a 10-foot length of static grounding cable, the free end of which has a grounding clamp.

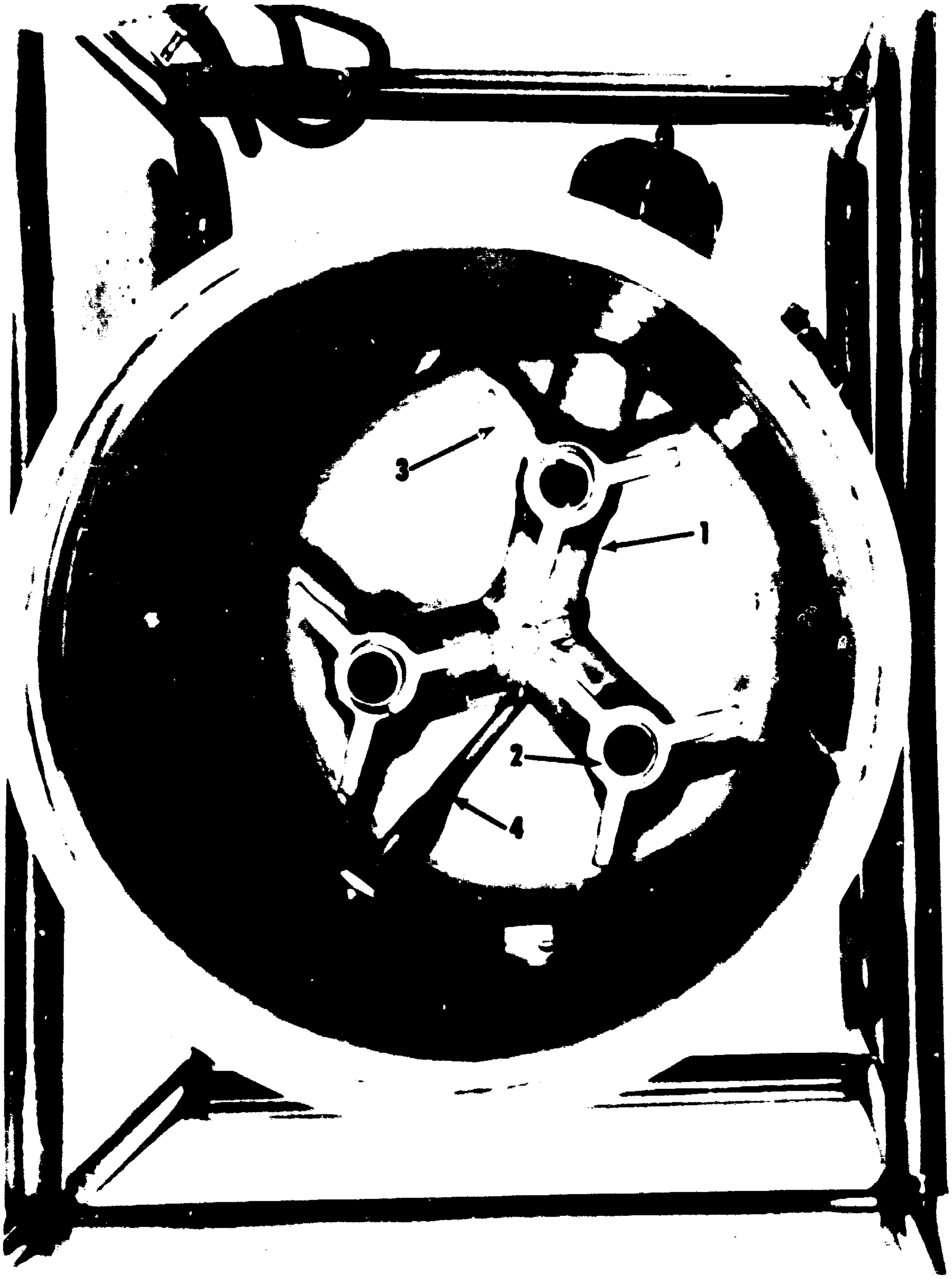
As contaminated fuel enters the inlet pipe it is directed through the Y-shaped manifold and risers, into the center void of the filter/coalescer elements. The fuel then passes radially through the fibrous walls of the elements, the solids particulate matter is retained on the inner layers, and the coalesced water is emitted from the outer surface of the elements as drops of 1/8- to 1/4-inch diameter. The drops of water and the fuel then impinge on the Teflon-coated metallic screen of the canister which encircles the element. The clean fuel passes through the screen to the outlet pipe. As previously mentioned, the water drops are repelled by the hydrophobic Teflon coating and fall down the annulus by gravity to the bottom of the vessel, where they accumulate to form a pool. The level of water accumulation is indicated by the ball-type sight glass. The accumulated water can then be drained manually by depressing the push-button water drain valve. Figures 1 through 5 show further details of the filter/separator construction.

The function of the flow limiter is to prevent the filter/separator flow rate from exceeding 75 gpm. The flow limiter consists of an orifice plate to which is mounted a spring-loaded baffle plate. The flow limiter is designed so that its pressure differential (ΔP) increases gradually with increasing flow to a predetermined limit or trigger point (Fig. 6, points A to B). If an attempt is made to increase the flow rate beyond the trigger point (approximately 72 gpm) the baffle plate quickly moves in to within 1/16 inch of the orifice plate. This reduces the open flow area, which results in a rise from point B to point C which also reduces the flow rate to 48 gpm. Thus, in the triggered position the ΔP across the flow limiter is 90 psi. If the losses through the remainder of the system are added to this value, the total system loss now becomes 98 psig at a flow rate of 48 gpm. As can be seen from the head-capacity curve of the pump, it is evident that the shutoff head is only 100 psi. Therefore, because the system loss is only slightly less than the shutoff head, it is impossible for the pump to deliver more than 72 gpm under these conditions; in fact, the flow rate may be substantially reduced. If, during a refueling operation, the flow limiter triggers and the flow rate is reduced too much, it then becomes necessary to either throttle a valve in the system or reduce the rpm of the pump engine so that the flow limiter opens or returns to its normal position, which is shown on Fig. 6 at point D.



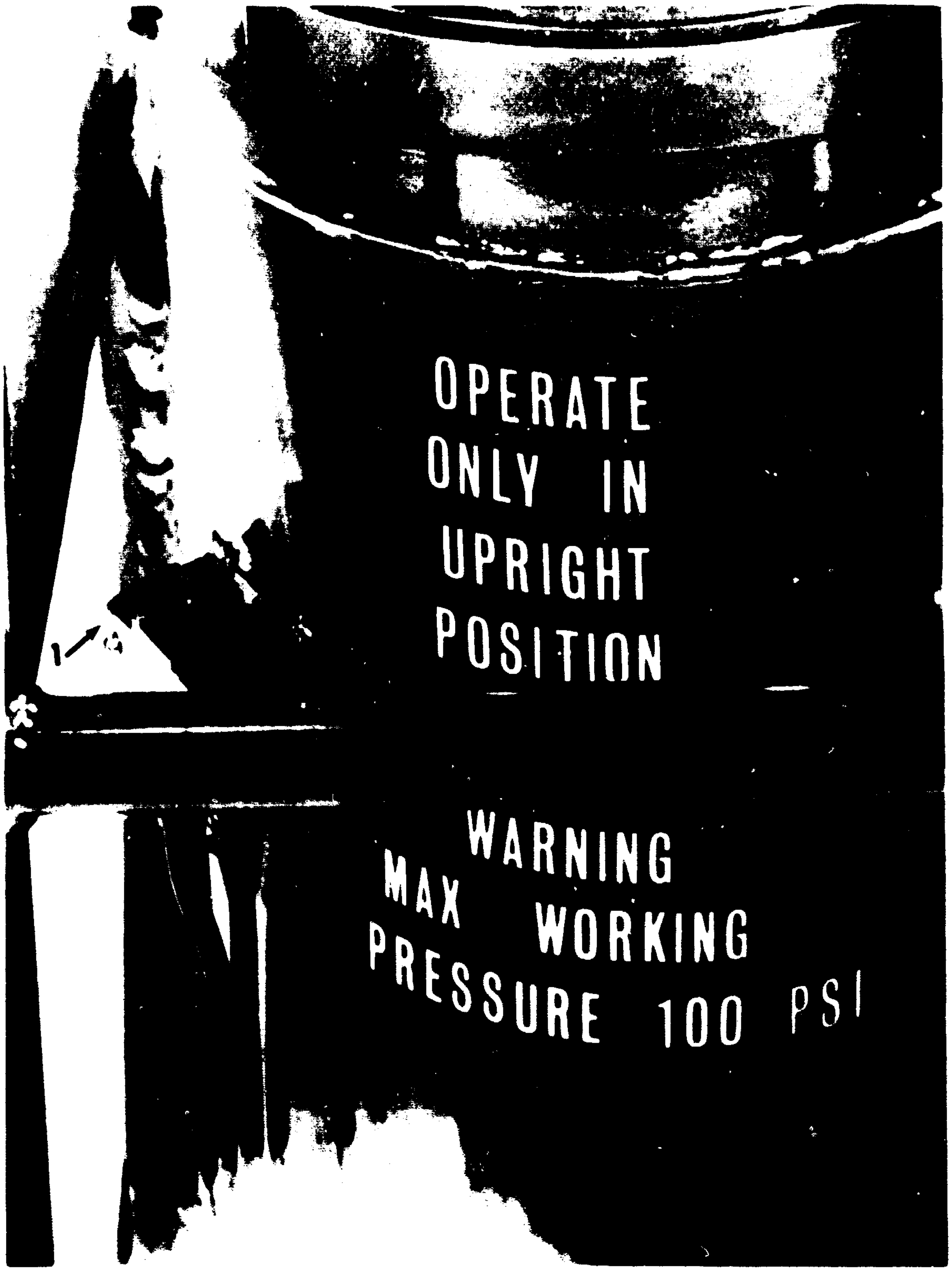
M7106

Fig. 1. Assembled developmental model of 50-gpm, optimum, light-weight, filter/separator showing: (1) Vessel body; (2) V-band coupling; (3) removable head; (4) air-release valve; (5) outlet quick-disconnect coupling and dust cap; (6) protective frame; (7) grounding cable; (8) inlet quick-disconnect coupling and dust plug; (9) water drain valve; (10) water level sight glass; and (11) decal instructions for water draining.



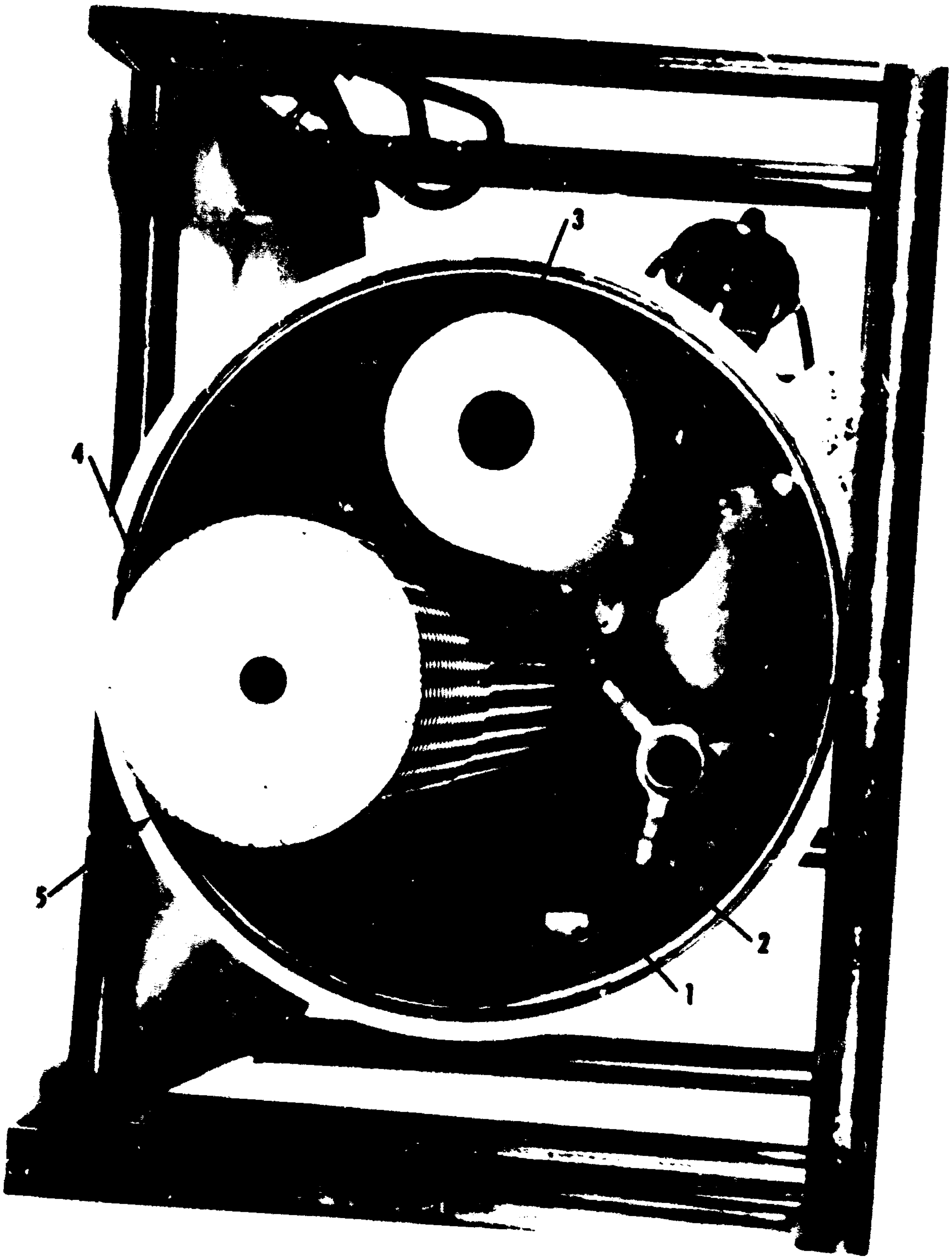
M7113

Fig. 2. Interior of filter/separator showing: (1) V-shaped inlet manifold; (2) element mounting risers; (3) canister-holding fingers; and (4) water drain tube.



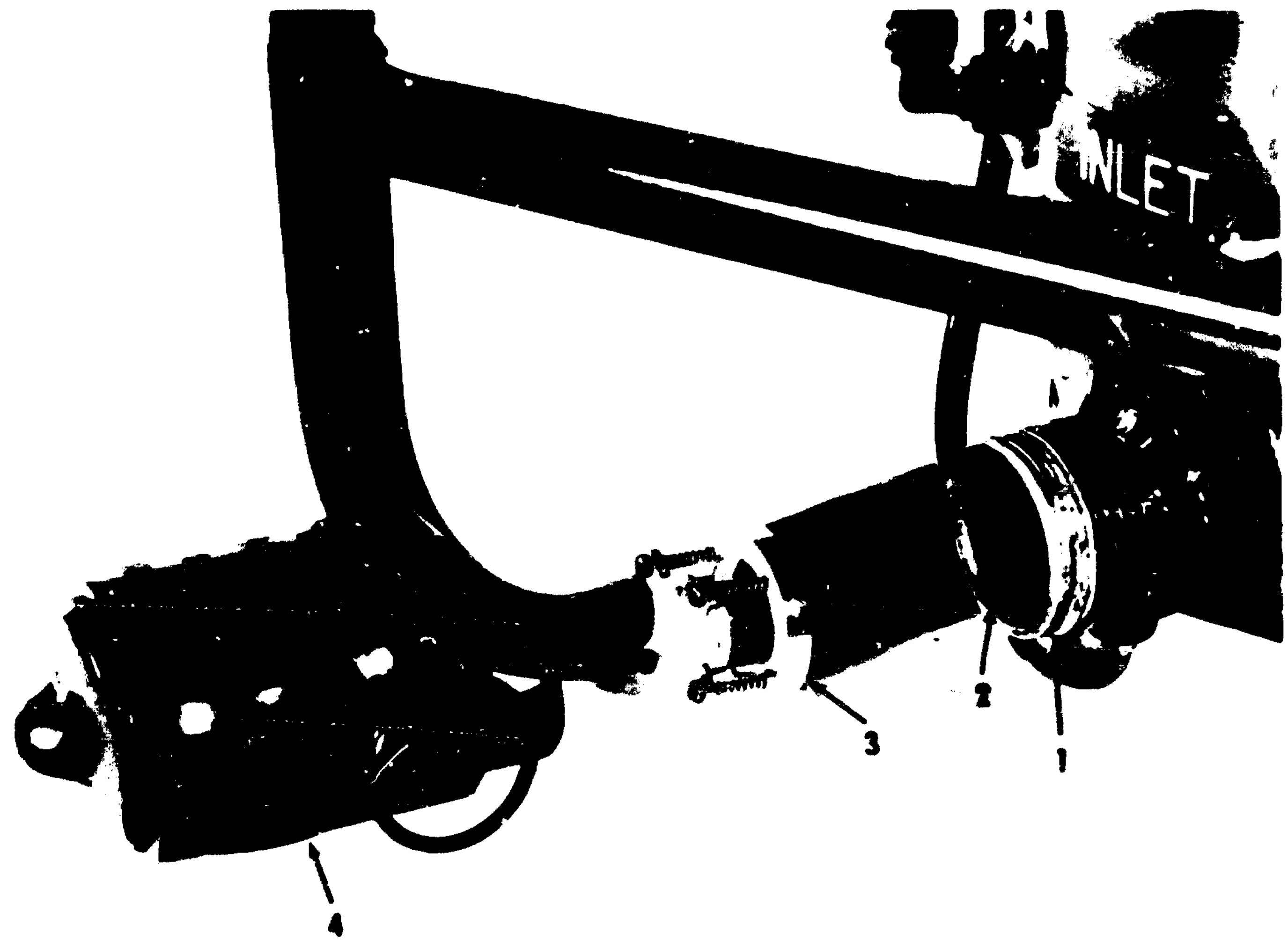
M7107

Fig. 3. Side of filter/separator showing: (1) Pressure differential indicator; and (2) decal instructions.



M7114

Fig. 4. Interior of filter/separator showing: (1) Y-shaped manifold; (2) radial arms on riser; (3) assembled element; (4) assembled element and canister; and (5) O-ring closure seal.



M7124

Fig. 5. Filter/separator inlet showing installation of flow limiter: (1) Inlet pipe; (2) cavity for receiving flow limiter; (3) flow limiter; and (4) quick-disconnect coupling and dust plug.

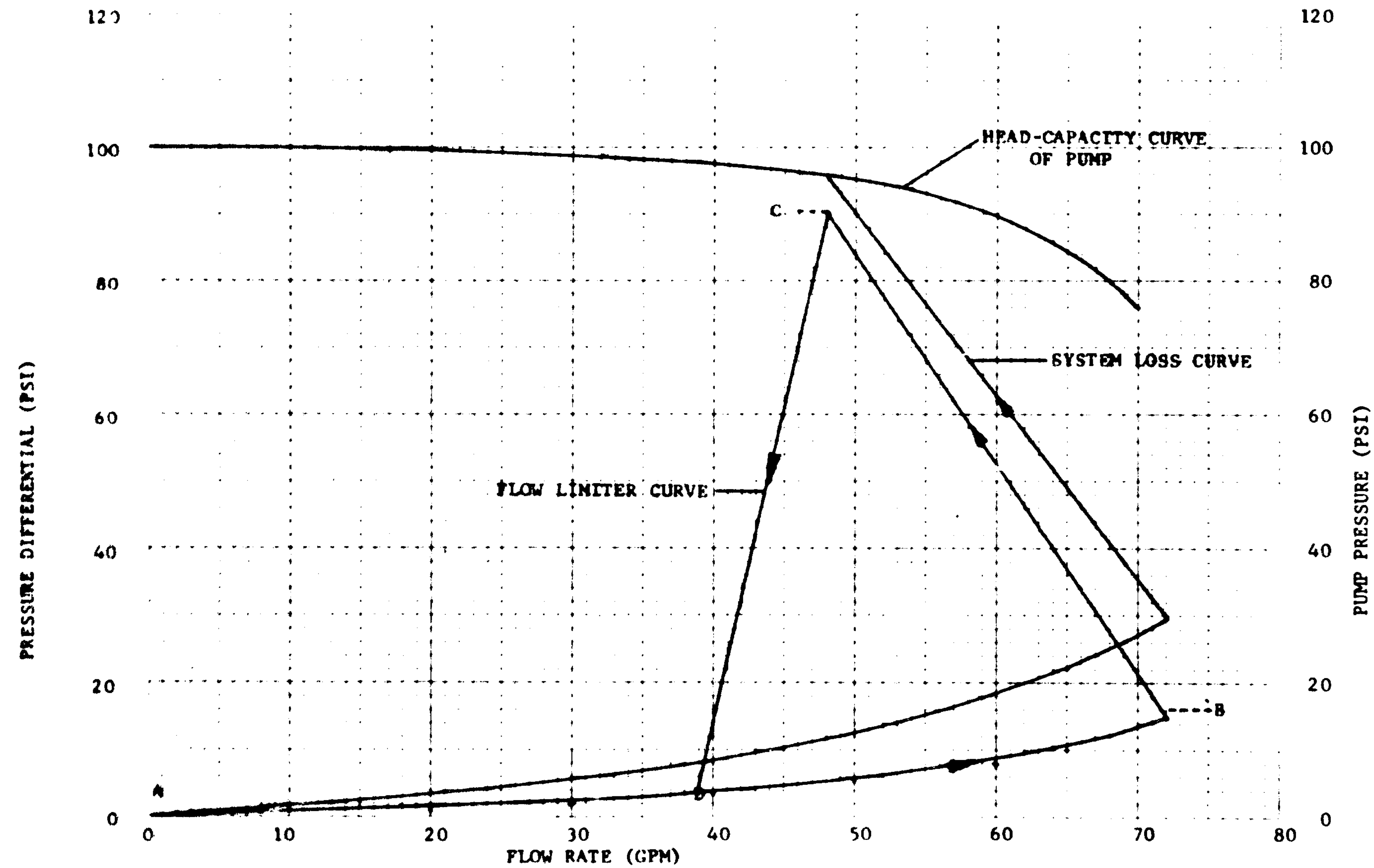


Fig. 6. Pressure differential vs flow rate characteristic curve for flow limiter.

6. Studies Performed during Development. In conformance with current policy, and in coordination with other USAERDL groups, several studies, reviews, and evaluations were performed during the development, as follows:

a. Value Engineering Review. Each component and part of the filter/separator were reviewed by the Engineering Analysis Branch of USAERDL to determine whether a cost reduction could be obtained without sacrificing performance. This study resulted in possible cost reductions in fabricating the canisters, the Y-shaped manifold, and the air-release valve system which could amount to an estimated saving of $13.75 per filter/separator.

b. Human Factors and Safety Review. A complete study of Human Factors and Safety was conducted by the Materials Research Laboratory, USAERDL. The study concluded that: "The present design as submitted for the 50-gpm filter/separator is considered safe for personnel in operation and maintenance from the Human Factors review. Human Factors consideration appears adequate."

c. Materials Analysis Study. Analyses of all the materials employed in fabricating the filter/separators were performed by the Materials Research Laboratory, USAERDL, to obtain an indication of the life expectancy of these materials under normal storage conditions. Results of the study indicated that all materials of the filter/separator will be completely effective after a storage period of at least 5 years.

d. Supplementary Quality Assurance Provisions. The design of the 50-gpm unit was reviewed by the Production Engineering Division of USAERDL to determine if a requirement for supplementary quality assurance provisions (SQAP) existed. No difficulties are expected to be encountered in establishing the quality assurance provisions.

e. Producibility and Production. The 50-gpm filter/separator design was reviewed to determine whether methods of fabrication were feasible and suitable for production. The results of the study indicated no problem areas existed.

II. DEVELOPMENTAL EVALUATION TESTS

7. Performance Requirements.

a. Water and Solids Removal. The water- and solids-removal performance required of all military filter/separators is specified in MIL-F-8901A. This specification also lists detailed procedures for conducting consistent and controlled evaluation tests of fuel filter/separators.

Table I, an abstract based on MIL-F-8901A, lists the tests conducted to determine the ability of a filter/separator to clean fuel which contains various levels of several different contaminants that normally occur in field operations.

b. Transportability.

(1) Rail Impact. A test is performed to determine the effect that railroad shipping and other types of transportation will have on Army equipment. It is required that the filter/separator be capable of being shipped in both vertical and horizontal positions. The filter/separator is required to be impacted once in each direction at speeds of 8, 9, and 10 mph. The filter/separator shall not be adversely affected by any of the impact tests.

(2) [illegible] Impact. A test is performed to determine the ability of the 50-gpm filter/separator to resist damage from shock caused by handling associated with transportation. It is required that the filter/separator not be adversely affected when subjected to this test.

8. Test Facilities.

a. MIL-F-8901A Tests. The existing USAERDL 15- to 50-gpm test facility, constructed in accordance with the requirements of MIL-F-8901A, was used for performing the tests on this filter/separator. This test system has a 1,000-gallon capacity, horizontal, aluminum storage tank. An electric motor-driven 3,450-rpm centrifugal supply pump furnishes fuel to a test loop and functions as a fuel-water emulsifier when water, as a contaminant, is injected upstream from the pump. All piping, valves, and fittings from the storage tank to the suction of the supply pump are of 2-inch size. All remaining pipe and fittings are $1\frac{1}{2}$ inches. A Fischer and Porter variable, area-type rotometer, periodically calibrated, is used to monitor and indicate the fuel flow rate during the tests. A 50-gpm vertical cleanup

Table I. Abstract of MIL-F-8901 Tests

Required Test	Test Objectives	Performance Requirements
Media migration	To determine stability of the fibrous materials utilized in element fabrication.	Maximum permissible solids content, average 0.5 mg/liter, single sample 1 mg/liter.
Water coalescence and removal	To determine ability of the filter/separator to remove water from fuel in concentrations of 0.5% and 0.01% by volume, at 125% of rated flow.	Maximum permissible water-in-fuel content, none (within the accuracy of the test method).
Cyclic water removal	To determine ability of the filter/separator to continuously remove 0.5% by volume of water from fuel during four 5-min runs with intervening 2-min shutdown periods between runs.	Maximum permissible water-in-fuel content, none (within accuracy of the test method)
Red iron oxide removal	To determine ability of the filter/separator to remove micronic and sub-micronic solid particles, with and without addition of 3% water by volume.	Maximum permissible solids-in-fuel content, 0.7 mg/liter. Maximum permissible water-in-fuel content, none (within accuracy of the test method).
Water and A. C. test dust removal, using test fuel containing corrosion inhibitor	To determine extent of reduced filtering and water removal capabilities occasioned by the presence of corrosion inhibitor in the test fuel.	Maximum permissible solids-in-fuel content, 0.7 mg/liter. Maximum permissible water-in-fuel content, none (within the accuracy of test method)
Life test with water and red iron oxide removal	To determine ability of the filter/separator to remove 0.5% water and red iron oxide after 125 hours of operation.	Maximum permissible solids-in-fuel content, 0.7 mg/liter. Maximum permissible water-in-fuel content, none (within accuracy of the test method).

filter/separator, which meets the requirements of MIL-F-8901, is located downstream from the meter, and is used to remove any residual water and solids present in the fuel, before returning the fuel to the storage tank. Temperature of the test fuel is maintained between 70^{o} F and 90^{o} F by means of a heat exchanger operating with steam or chilled water, as required. Conventional temperature and line-pressure instrumentation are used for control of test conditions. The specified quantity of test-water contaminant is measured with a Fischer and Porter variable, area-type rotometer, and is injected into the previously cleaned test fuel at the suction side of the supply pump. The water is filtered before injection. An Omega continuous-type dust feeder is used for measuring the dry-solids contaminants. A blending tank and a Moyno metering pump are provided for mixing and injecting the fuel-water-red iron oxide emulsion required for the tests.

b. Rail and Drop Impact Tests. Facilities of the Shock and Vibration Branch, Instrumentation Division, USAERDL, were used.

The rail impact test facilities consisted of three ordinary railroad cars with standard draft-gear couplings, a prime mover for moving the cars, a calibrated means to determine the speed at the time of impact, and accelerometers and associated circuits to measure the impact shock.

A Mark 7 bomb release was used for conducting the drop impact tests. This consisted of a cable lift mechanism designed to release the filter/separator from a predetermined height so as to allow free fall to a concrete floor.

9. Test Fuel and Contaminants.

a. Test Fuel. Kerosene conforming to Federal Specification VV-K-220, "Kerosene, Water-White, Deodorized (for use in Insecticides)," 1 May 1957, was used as the test fuel. This kerosene, specified in MIL-F-8901A, was selected because its characteristics are not permitted to vary widely from batch to batch, with consequent greater uniformity of test conditions.

b. Water Contaminant. The water injected into the test fuel during the tests was that available at the test site from the Fort Belvoir utility system. Before the water was used, it was filtered to a residual solids level of 0.8 mg/liter.

c. Red Iron Oxide Contaminant. Fisher Scientific Company's red iron oxide I-116 was used. Approximately 94 percent of this material is less than 1 micron in size. Table II in MIL-F-8901A gives complete particle size distribution.

d. A. C. Dust Contaminant. A. C. Spark Plug Company's Test Dust Part 1543637 was used. Approximately 90 percent of this material is less than 80 microns in size. Table III in MIL-F-8901A gives complete particle size distribution.

10. Sample Analysis Procedures. The Karl Fischer analysis method is employed in determining the minute quantities of water which are found in filter/separator effluent samples. The method determines the total water content, which is a combination of the free water and the water in solution, by direct electrometric titration in methanol with Karl Fischer reagent. The reagent reacts quantitatively with the water extracted from the fuel by anhydrous methanol. The detailed procedure can be found in par. 4.6.7.4.2.1 of MIL-F-8901A. The free or undissolved water in the fuel is the difference between the total water content of the effluent sample, as obtained by the Karl Fischer method, and the average total water content of not less than three uncontaminated samples.

The solids content of the test filter/separator effluent stream is determined by filtering a test sample of known volume through a tared Millipore filter. This filter is a thin, cellulosic, porous membrane which has an average pore size of 0.8 micron (0.000032 inch). The Millipore filter, with any accumulation of solids from the test fuel, is then washed with a particle-free solvent to remove the residual fuel and dried for 1 hour at 200° F. After the Millipore filter is cooled to constant weight, it is again weighed, the increase in weight being solids removed from the test sample. Extreme care is exercised during this analysis to prevent extraneous contamination of the filters from airborne particles, washing solvents, or other sources. Detailed procedures can be found in par. 4.6.7.4.1 of MIL-F-8901A.

11. Test Procedures and Results.

a. MIL-F-8901A Tests. Test procedures conformed to the requirements of MIL-F-8901A. Water- and solids-removal performance data from the test series are summarized in Table II in this report.

(1) Inspection (par. 4.6.1, MIL-F-8901A). Before tests were conducted, the 50-gpm filter/separator was visually

Table II. Water and Solids Removal Performance

Test	Pressure Differential (psi)		Free Water Content (mg/liter)		Solids Content (mg/liter)	
	Limit	Performance	Limit	Performance	Limit	Performance
Media Migration	--	--	--	--	0.5	0.1 avg
Water Separation						
0.5% injection	--	9.5	No free water within accuracy of test method	None	--	--
0.1% injection	--	8.0	"	"	--	--
0.5% injection (cyclic)	--	8.5	"	"	--	--
Water and/or Solids Injection						
Red iron oxide and 3% water	<40 at 70 min	17.2 at 70 min	"	"	0.5	0.06 avg
Red iron oxide (dry)	<40 at 70 min	6.0 at 70 min	--	--	0.5	0.23 avg
Life test, with intermittent 0.5% water and red iron oxide removal	<40	14.	No free water within accuracy of test method	None	0.5	0.077 avg
A. C. dust, 1% water injection, inhibited fuel	<40 at 130 min	23 at 130 min	"	"	0.5	0.09 avg

Note: Dashes signify no data were required.

inspected for conformance to drawings and workmanship requirements. The inspection indicated that the filter/separator had been fabricated in accordance with the detail drawings.

(2) Hydrostatic Pressure (par. 4.6.2, MIL-F-8901A). This test was performed on each of the filter/separator vessels at the Contractor's facilities. A pressure of 150 psi was applied to the vessel for a minimum of 5 minutes, during which time all joints, seals, and welds, were checked for leakage. All of the filter/separators satisfactorily passed the test. All welds and joints were acceptable.

(3) Coalescing Ability (par. 4.6.4.1, MIL-F-8901A). Before the full-scale tests were conducted, each filter/coalescer element was subjected to a coalescing test. The purpose of this test was to determine, before actual performance tests, if defects in materials of fabrication existed or if handling damage had occurred which would adversely affect performance. In the test, the existence of oversize fluid passages is evidenced by a visible emulsion cloud in the testing tank of clear fuel. All elements tested satisfactorily passed this test.

(4) Pressure Drop (par. 4.6.5.2, MIL-F-8901A). The test vessel was assembled into the test system, and the pressure differentials at various flows were measured between the inlet and outlet pressure taps of the unit. The specification requires that the pressure differential shall not exceed 5 psi at 125 percent of rated flow during this test. Results were satisfactory and are shown in Fig. 7.

(5) Media Migration (par. 4.6.5.2, MIL-F-8901A). During the pressure drop test, samples of the effluent fuel were taken at each of the seven time periods prescribed for solids-content analyses. This test determines the degree of cleanliness of the element and the mechanical stability of the element materials. MIL-F-8901A allows a maximum of 0.5 mg/liter of media migration. Results showed that the maximum solids content of any of the effluent fuel samples was 0.2 mg/liter.

(6) Water Separation (par. 4.6.6.1, MIL-F-8901A). The water-separation tests determined the ability of the filter/coalescer elements to provide specified water-removal performance throughout the prescribed range of water concentration. The water

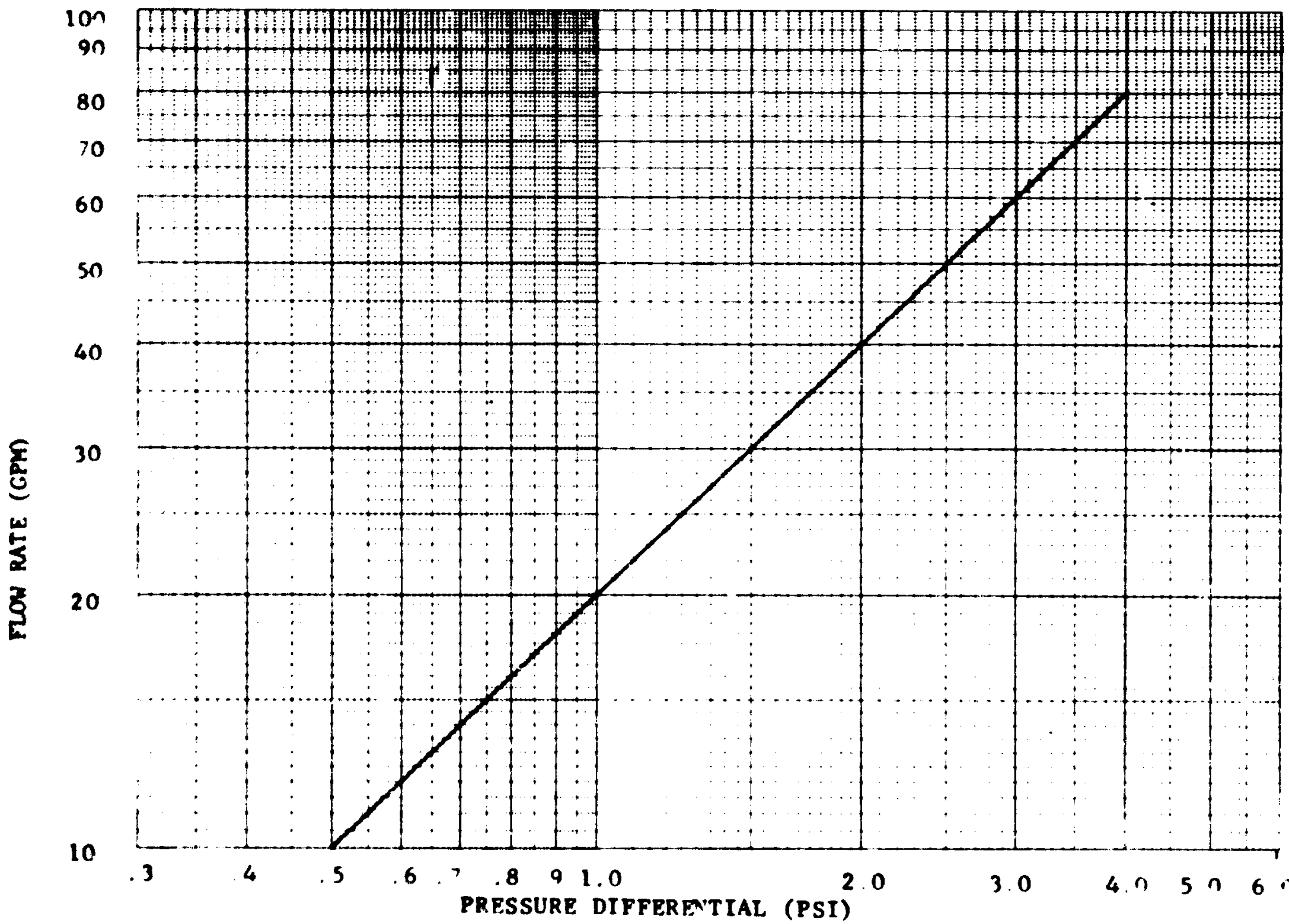


Fig. 7. Pressure differential vs flow rate characteristics of optimum, lightweight filter/separator during pressure drop test.

test contaminant was injected on the suction side of the pump in concentrations of 0.5 and 0.01 percent by volume for 1 hour at each concentration. The 10 percent concentration is not required for this particular filter/separator application, and was not performed. Test filter/separator effluent samples and cleanup filter/separator effluent samples were taken as prescribed by the specification. Evaluation of the sample analyses indicated that no free water was present in any of the samples. Samples of the separated water were also taken. The fuel content of the water separated by the filter/separator was well within the specification limits. Variations in pressure differential during the water injection runs are shown in Fig. 8.

(7) Water Slug Control Test (par. 4.6.6.2, MIL-F-8901A). This test was not required on the 50-gpm unit because it is not equipped with automatic controls.

(8) Cyclic, with Water Injection (par. 4.6.6.3, MIL-F-8901A). This test was intended to determine the filter/separator's ability to perform satisfactorily under surge-flow conditions, created by starting and stopping the main circulating pump. Water (0.5 percent by volume) was injected during the four 5-minute pumping periods at rated flow, with 2-minute shutdowns during which time no water was injected. Effluent fuel samples were taken from the test and cleanup filter/separators and analyzed for total water content. Evaluation of the sample analyses indicated no free water was present.

(9) Red Iron Oxide Slurry and 3 Percent Water Removal (par. 4.6.6.4, MIL-F-8901A). This test determined the ability of the filter/separator to remove extremely fine iron oxide when mixed with water and fuel previously emulsified by the action of a high-speed supply pump. During the test, 3 percent water by volume and 0.0035 pound of red iron oxide emulsion per gallon of fuel flow were injected. The elements are required to extract and retain the solid contaminant, and to separate the water from the fuel by coalescing the fine water droplets into drops that can be removed by the Teflon-coated canister screen. The specification requires that the elements retain a quantity of solids equal to 10 times the rated flow expressed in grams. This amounts to 500 grams in a 70-minute period, injected at the specified rate of 0.0035 pound of emulsion per gallon of fuel flow (37.5 mg/liter of dry solids). This specification states further that at the end of the 70-minute period and after the required quantity of solids has been retained, the pressure differential across the filter/coalescer elements shall not exceed 40 psi. The specification

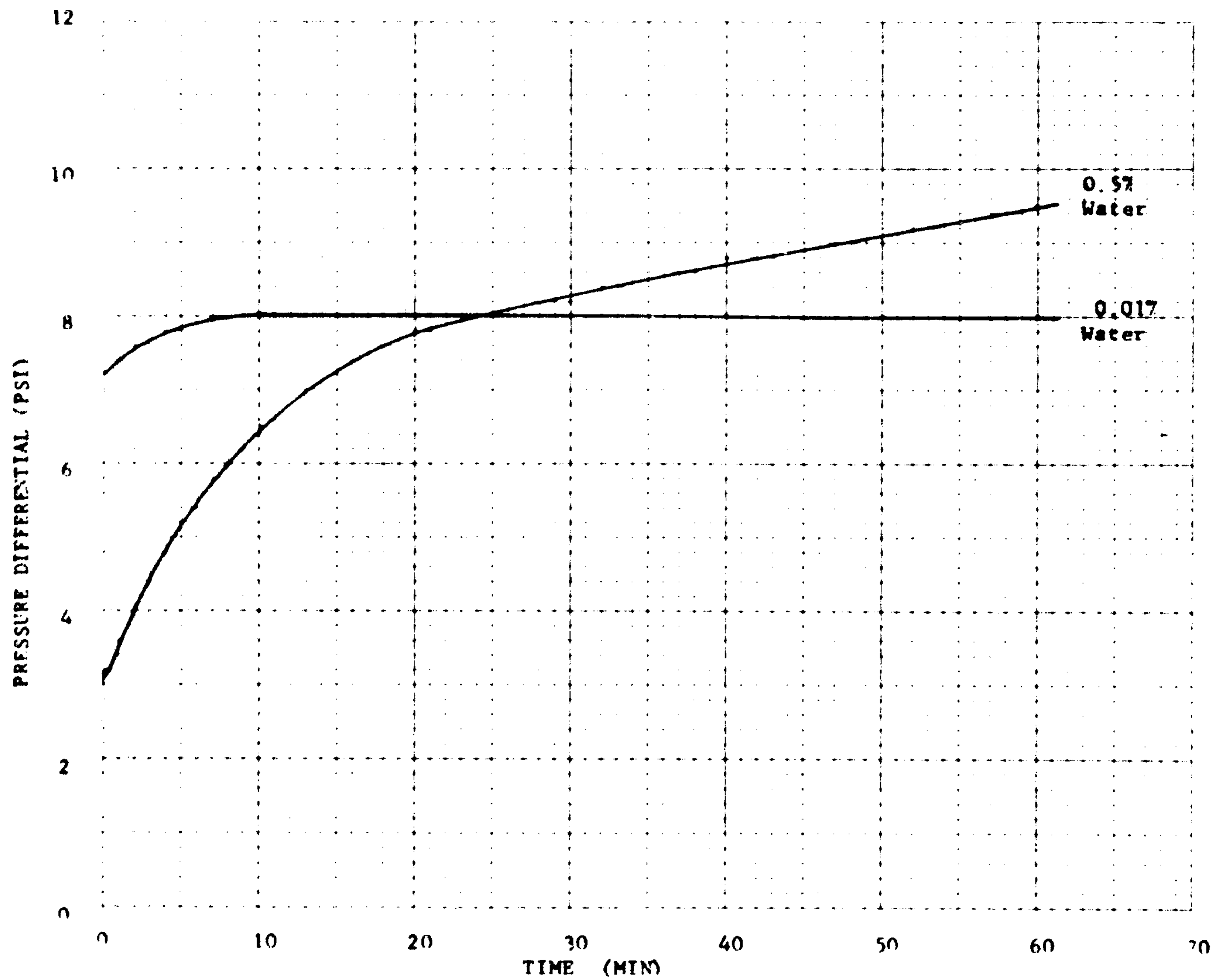


Fig. 8. Pressure differential vs time characteristics of filter/separator during water-removal tests.

also requires that the test be then continued until a pressure differential of 40 psi is reached. Evaluation of the results of the sample analyses indicated that no free water was present nor did the residual solids content exceed the specification limit. The highest solids content in any single sample was 0.2 mg/liter, which is below the limit. The average solids content was found to be 0.06 mg/liter, also below the limit of 0.7 mg/liter for an average of all samples. At the 70-minute interval the pressure differential was 17.2 psi. The pressure differential characteristics that resulted from solids and water accumulation versus elapsed time are shown in Fig. 9.

(10) Red Iron Oxide Removal Without Water in Test Fuel (par. 4.6.6.5, MIL-F-8901A). This test was conducted to establish a comparison between solids-removal performance of the filter/coalescer elements when the fine solids may be agglomerated by the presence of water, as in the previous test, and when the solids remain finely dispersed in the absence of water. Results of analyzed effluent fuel samples indicated that the residual solids content averaged 0.02 mg/liter, which is well below the specification limit of 0.7 mg/liter. This test was continued until 40-psi pressure differential was obtained at an elapsed time of 132 minutes. At the end of this period, the elements had removed a total of 1,190 grams as compared to the required amount of 500 grams. The intermediate and final pressure differentials during the test are shown in Fig. 9. The test was not continued to a pressure differential of 75 psi required by the specification. Extension of the test to 75 psi is primarily intended as a mechanical integrity test for filter/coalescer elements. The elements are bought centrally and are always subjected to this test in a pressure vessel of commensurate strength. However, the 50-gpm optimum, lightweight filter/separator was not designed for or required to withstand 75-psi pressure differential; therefore, this test was not performed.

(11) Life Test with Intermittent Water and Red Iron Oxide Removal (par. 4.6.6.6, MIL-F-8901A). This test was conducted to determine whether the water- and solids-removal capabilities of the filter/separator would be adversely affected after prolonged exposure to fuel flow with intermittent water and solids contaminant injection. This test lasted 145 hours during which time 0.5 percent by volume of water contaminant was injected for the first hour of each 8-hour period. Red iron oxide contaminant was added dry at the rate of 0.000315 lb/gal at the beginning of each 8-hour period, as required to produce a pressure differential of 10 psig across the filter/separator. During

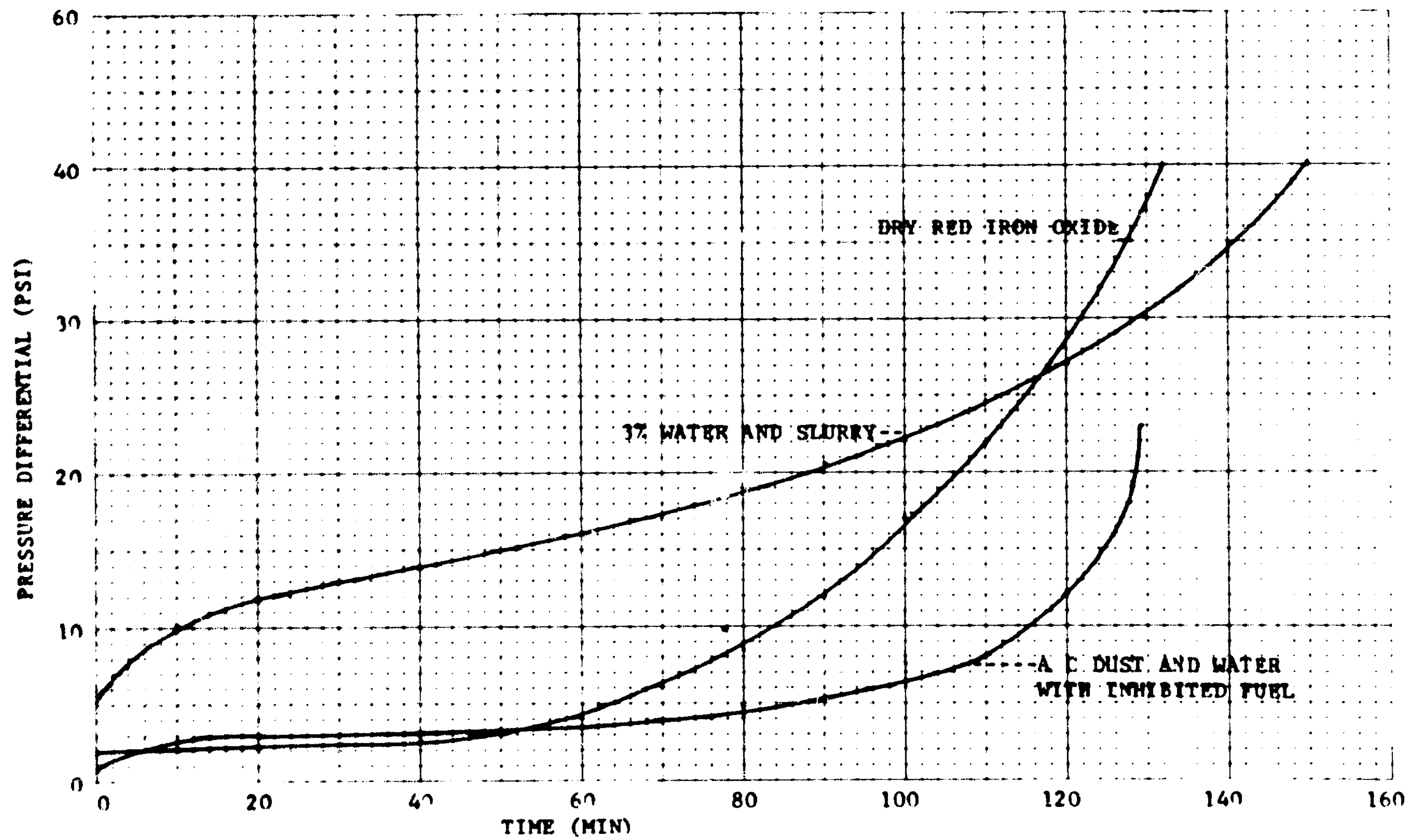


Fig. 9. Pressure differential vs time characteristics of filter/separator during solids- and water-solids removal tests.

this test, a total of 992 grams of red iron oxide were injected as compared to the required amount of 500 grams. No free water was present in the effluent samples as determined by the Karl Fischer method. The average residual solids content of all samples was 0.08 mg/liter. During the life test, it was found that the water drain valve leaked and that the leak could not be stopped. Disassembly of the valve revealed that the O-ring seal had rolled out of the groove. This deficiency was corrected as described in par. 10b.

(12) Water and AC Dust Removal; Test Fuel Containing Corrosion Inhibitor (par. 4.6.6.7, MIL-F-8901A). This test was conducted to determine whether changes in fuel characteristics resulting from addition of Santolene C corrosion inhibitor additive would adversely affect water- and solids-removal capabilities of the filter/coalescer elements. Analyses of effluent fuel samples indicated that no free water was present. The effluent samples contained an average of 0.09 mg/liter of residual solids as compared to the specification limit of 0.5 mg/liter. Results indicated that the addition of the corrosion inhibitor did not adversely affect performance of the filter/separator. Intermediate and final pressure differentials are shown on Fig. 9.

b. Retest of Modified Water Drain Valve. As previously mentioned, during the MIL-F-8901A tests difficulty was experienced with the water drain valve. The O-ring on the seal plug rolled out of the groove several times and resulted in leakage of the valve. To remedy this problem, a channel was drilled as a vent from the O-ring groove to the low-pressure side of the valve. The valve was then reinstalled on the filter/separator in the test system, and actuated more than 500 times while various quantities of water were injected, and while the unit was operating at various pressures. The O-ring remained in the groove during all the cycles of the actuation, and no leakage was encountered. All other units were also then modified by venting the O-ring groove.

c. Rail Impact Test. Two ordinary railroad cars located on a level section of track were used as buffer cars. The buffer cars were loaded with 80,000 pounds of steel armor plate. The air brakes were set in the emergency application position for both cars. The filter/separator was mounted on the impact end of a flat-bed test car, in direct contact with the car floor, and adequately blocked to prevent any longitudinal, vertical, or lateral movement. The test car with the filter/separator was then impacted into the buffer cars successively at 8, 9 and 10 mph with each of the vertical sides of the filter/separator, top and bottom, absorbing the

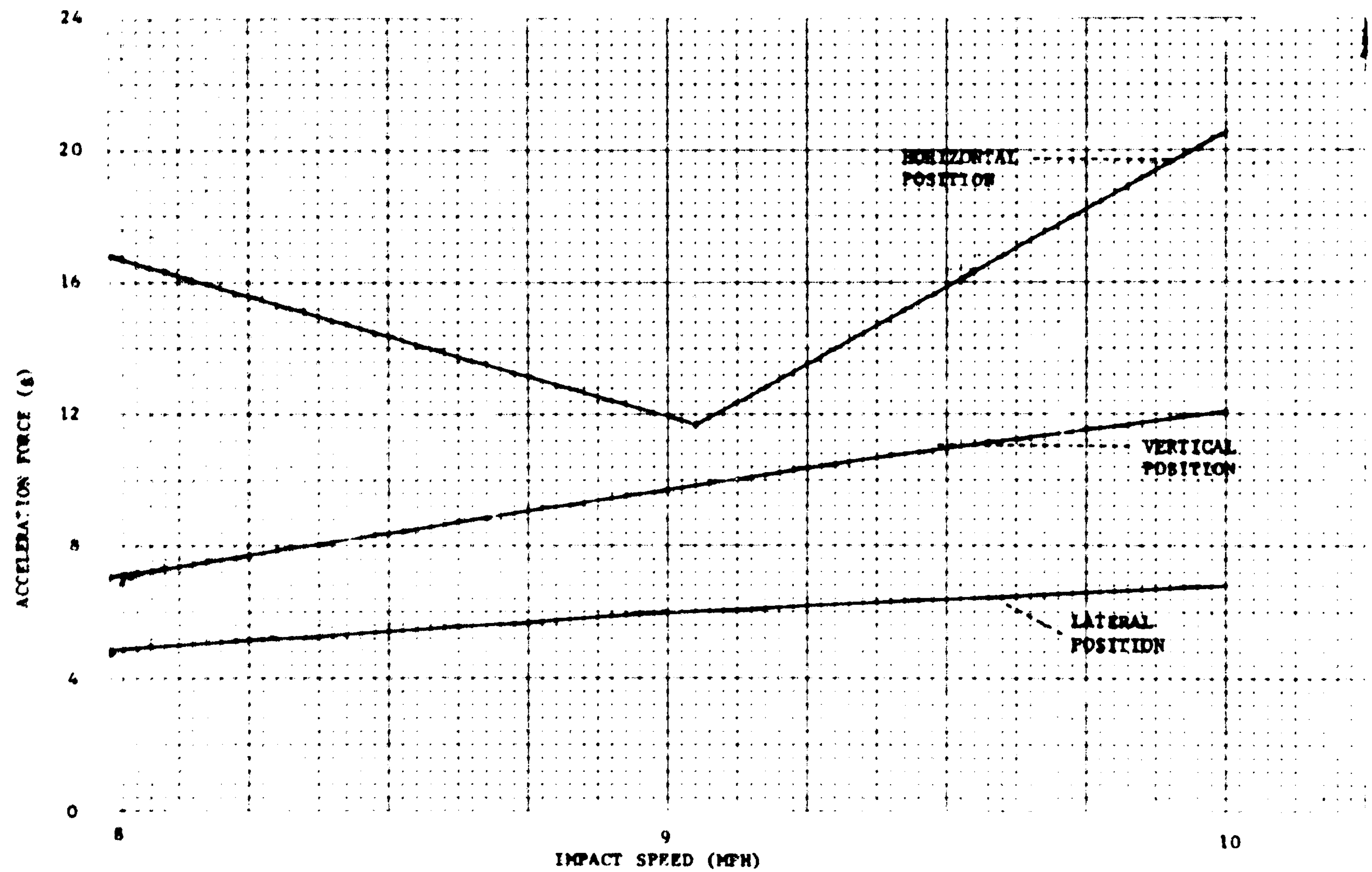


Fig. 10. Typical impact speed vs shock force characteristics during rail impact test.

impact. The filter/separator was subjected to a total of 18 impacts without benefit of crating or packaging other than O-ring spacers around the top of the canisters. The speed just prior to impact was measured by electrical signals. Accelerometers were mounted in three planes, both on the test car and on the filter/separator. Typical forces to which the filter/separator was subjected are shown in Fig. 10. No visual adverse effects could be seen after any of the impacts. A 1-hour, 0.5 percent water separation test was performed on the filter/separator both before and after the unit was subjected to the rail impact tests. The results of the water-removal tests were satisfactory and showed no free water in the effluent fuel samples.

d. Drop Impact Test. The filter/separator was mounted in the Mark 7 bomb release and raised to a height of 21 inches, at which point the release was actuated allowing a free drop to a concrete floor. This procedure was repeated. It was observed that two minor welds on the frame were slightly cracked; however, these had little effect on the frame strength. The frame was still intact, and serviceability was not impaired. A 1-hour, 0.5 percent water-separation test was then performed on the filter/separator with satisfactory results.

III. DISCUSSION

12. Conformance to Design Criteria.

a. Operational Requirements. The essential operational requirements as listed in the SDR are discussed here; paragraph numbers correspond to those listed in par. 3 of this report.

(1) The engineering design tests resulted in satisfactory performance under intermediate climatic conditions. The engineering-test/service-test (ET/ST) phase is intended to verify performance under the intermediate climatic conditions as well as to determine effectiveness in warm-wet climatic conditions and hot-dry climatic conditions.

(2) The engineering design tests have indicated the ability of the filter/separator to perform satisfactorily with a particular referee fuel, and it is known that if the filter/separator works with this fuel it will perform with all other military fuels. ET/ST is planned to verify the ability of the filter/separator to perform satisfactorily with all military fuels.

(3) Results of MIL-F-8901A tests of the 50-gpm unit indicate satisfactory performance.

(4) The filter/separator has performed satisfactorily on both an intermittent and continuous flow basis, as verified by the life test.

(5) Satisfactory performance when the filter/separator is subjected to pressure surges has been verified by the cyclic test of MIL-F-8901A.

(6) Design of the 50-gpm unit utilizes a minimum amount of welding and machine work.

(7) The silhouette of the filter/separator is lower than any other vertical commercial or military filter/separator of equal capacity, and it also has a low center of gravity.

(8) The filter/separator has not been adversely affected when subjected to rail impact and drop impact tests, which indicates that it is sufficiently rugged to withstand shocks and vibrations normal to military transportation.

(9) Operation of the filter/separator has been simplified and is such that troops or civilians can easily operate it after less than 2 hours of on-the-job instructions.

(10) Proper operation of the filter/separator will result in no safety hazards to operating personnel. The ET is intended to substantiate this determination. A safety statement has been prepared and distributed.

(11) The filter/separator is considered to be as immune to enemy radiological, chemical, and biological operations as the associated equipment used with it.

(12) The dimensional and weight requirements of the pressure vessel with and without the tubular frame have been met as shown in Table III.

Table III. Dimensional and Weight Requirements of the Filter/Separator

Pressure Vessel	Essential	Desired	Actual
w/o Frame			
Height (in.)	32	29	30
Diameter (in.)	14	12	12
Dry Weight (lb)	36	34	36*
w/Frame			
Height (in.)	34	32	32
Width (in.)	16	15	14
Length (in.)	20	18	20
Dry Weight (in.)	60	50	58

* Based on the prototype unit.

(13) The filter/separator will require less than 1 hour to service and check out the unit for recommitment, which includes replacement of expended filter/coalescer elements if needed. This is to be verified during ET/ST.

(14) After the unit has been placed in operation, the reaction time, that is, the time required for fuel to pass through the filter/separator, will not exceed 15 seconds.

(15) Accumulation of 150 hours of total test time during the MIL-F-8901A tests indicates that the required 90 percent reliability for a mission time of 15 hours will be exceeded. Although the water drain valve leaked during tests, this was an engineering deficiency which has been corrected, and was, therefore, not considered a reliability failure. Retest of the modified valve has indicated satisfactory performance after 500 cycles of operation, which is approximately three times the number of cycles applied during 150 hours of testing.

(16) The combat-ready rate cannot be determined during the engineering development phase at a development laboratory.

b. Maintenance Requirements. The 50-gpm optimum lightweight filter/separator has been designed to meet the maintenance requirements (par. 3b) by simplicity of design, repair by replacement, and the like. A determination must be made, however, during ET/ST, if all requirements have been met under actual field use conditions.

13. Exception Taken to SDR. The SDR states as a nonessential requirement that: "Go-No Go built-in checking devices shall be incorporated wherever practicable." The built-in "Go-No Go" checking device has not been incorporated into the design of the 50-gpm filter/separator. This exception has been taken because it has been concluded that the stated requirement is unrealistic, that the device would be an un-needed refinement, and that its use would unnecessarily increase size, weight, and cost of the filter/separator. It will be recommended at the In-Process Review that this requirement be deleted.

14. Status of Procurement Data. To meet type classification requirements, and preparatory to procurement, the following procurement data on the military design, 50-gpm, optimum, lightweight filter/separator have been prepared:

a. Complete fabrication drawings, identified as U. S. Army Mobility Command Data List 13213E5090, covering the aluminum vessel, canisters, and other accessories.

b. "Purchase Description of Filter/Separator Vessel, Liquid Fuel," September 1964. This purchase description supplements the vessel drawings and will be converted to a military specification upon type classification of the item.

c. Military Specification MIL-F-52308, "Filter Element, Fluid Pressure," 2 August 1963. This specification covers the dimensional details and performance requirements for the filter/coalescer elements used with the filter/separator as expendable, replaceable components.

d. Military Specification MIL-F-8901A, "Filter/Separators, Aviation and Motor Fuel, Ground and Shipboard Use, Performance Requirements and Test Procedures for", 4 October 1963.

With these procurement documents, the 50-gpm optimum lightweight filter/separator utilizing standard dimension elements can be procured with the assurance that performance will fully meet the latest requirements.

15. Estimated Production Costs. Any well-equipped pressure vessel manufacturing plant having light aluminum fabrication experience, should be able to effectively fabricate the filter/separator vessels. It is estimated that in production quantities of 100 and 500 units, the cost per filter/separator would be \$250 and \$300, respectively. The filter/coalescer elements when requisitioned by Federal Stock Number from Supply Depot stock would cost less than \$4 each.

IV. CONCLUSIONS

16. Conclusions. It is concluded that:

a. The 50-gpm optimum, lightweight filter/separator, when tested under the conditions specified in MIL-F-8901A, meets all established water- and solids-removal performance requirements.

b. All requirements of the Small Development Requirement are met except the requirement for incorporation of the "Go-No Go gage" device. An exception is taken because it is concluded that the stated requirement is unrealistic, and that it is an unnecessary refinement which would increase the size, weight, and cost of the filter/separator.

c. The filter/separator, without further modification, is suitable for integrated engineering and service tests.

APPENDIX

AUTHORITY

RESEARCH AND TECHNOLOGY RESUME			DA OA 3767	CSCRD-103
10 15 65	F PLAN (CHANGE) 06 15 65	U U	N/A	NL	D Task Area
6.41.33.24.1 1M643324D59209			6.41.33.24.1 1M643324D59209		
(U) Fuels Decontamination Equipment					
Fibers and textiles; physical chemistry; pumps, filter, pipes, fittings, and valves			N/A	N/A	N/A
N/A	Date 06 65; Number AMC-1165(T); Type M CPFF; Amount 41,113		(65) (66)	5 5	184 170
U. S. Army Engineer Research and Development Laboratories, Fort Belvoir, Virginia 22060; L. L. Stark, 703 781-8500 X-45746			Ethyl Corporation, 1600 W. 8-Mile Rd, Ferndale 20, Michigan; Ellis Rifkin, H. A. Beatty, 564-6940		N

Liquids filtration and dehydration

Liquid fuels, dehydration and decontamination

24 (U) Objective of Task: Conduct research, design, development, test, and evaluation to produce fuel decontaminating units required for fixed, mobile, and portable applications in sizes 15 to 600 gpm. Conduct basic and applied research into the phenomena of filtration and water coalescence to provide design criteria for a vastly superior element that can be mass-produced with effective quality controls.

25 (U) WORK PLAN FY67: Continue basic and applied research in the problems of fine particle filtration and water coalescence. Monitor, support, review, and evaluate results of ET/ST of 50 and 350 GPM Filter/Separator, Optimum Lt Wt Design; accomplish EDT of the 600 GPM Filter/Separator, Optimum Lt Wt Design, evaluate results, accomplish design revisions, prepare engineer report and coordinate plans for ET/ST; continue development of the High Performance Military Design Filter/Separator Element to include fabrication and evaluation of prototypes; initiate feasibility studies for development of Filter/Separator, 20 GPM Lt Wt Horizontal and the 15 GPM Filter/Separator, Discardable. Continue studies covering the effects of fuel additives on filtering and coalescence. Furnish technical assistance to other DOD elements, prepare drafts of concepts and new materiel requirements.

26. (U) WORK PLAN FY68: Initiate TC of 50 and 350 GPM Filter/Separator, Optimum Lt Wt Design; coordinate production, human factors, value engineering, and safety reviews, furnish technical assistance in preparation of maintenance support plan, draft technical manual, quality assurance provisions, specifications, drawings, Monitor ET/ST of 600 GPM Filter/Separator, Optimum Lt Wt Design, complete evaluation of High Performance Military Design Filter Separator Element.

X	DT	7
CDOG Paras 1610b(1), 1610b(6), 1612b(5) and 1612b(7)	: None Coordination: Dept of Navy, U. S. Air Force	
	None	
169		

DD FORM 1498

FY 67-68 PROGRAM DATA SHEET

PROJECT OR TASK NO.: 1M643324D59209 | 37. CDOG Priority

PROJECT OR TASK TITLE:

Fuels Decontamination Equipment

38. FUNDING (In thousands)

TYPE	FY 66	FY 67	FY 68	FY 69	FY 70	FY 71	FY 72	TO COMPLETE
a. INHOUSE AMC	119 (0)	129 (5)	89 (0)					
b. CONTRACTUAL	51	40	0					
c. OTHER	0	0	0					
d. TOTAL	170 (0)	169 (5)	89 (0)	76 (10)	50	51	75	300

39. PLANNED PROCUREMENT, DELIVERY, & TEST OF TEST ITEMS

TYPE TEST	PROCUREMENT FY	COST	QTY	TEST FY	SITE	COST	QTY	TEST SYM	DELVY TO SITE	START TEST	COMPLETE TEST	SUBMIT REPORT	NOTES
a. Filter/Separator Research (Research Only - No End Items)													
b. 350 GPM Filter/Separator, Optimum Lightweight Design													
R&D Accept	65	13	6	66	ERDL	N/A	1	R&D Accept	2Q66	2Q66	3Q66	3Q66	1
ET	65	N/A	N/A	66	GETA	N/A	1	ET	2Q66	2Q66	4Q66	2Q67	
ST	65	N/A	N/A	66	STD	N/A	1	ST	2Q66	2Q66	1Q67	2Q67	
ST	65	N/A	N/A	66	STA	N/A	1	ST	2Q66	2Q66	4Q66	2Q67	
c. High Performance Military Military Design Filter/Separator Element													
R&D Accept	67	5	250	Coordinated Test Plan to be developed.									
d. 600 GPM Filter/Separator, Optimum Lightweight Design													
R&D Accept	66	21	4	66	ERDL	N/A	1	R&D Accept	4Q66	1Q67	2Q67	4Q67	2
ET	66	N/A	N/A	66	GETA	N/A	1	ET	3Q67	3Q67	1Q68	2Q68	
ST	66	N/A	N/A	66	STD	N/A	1	ST	3Q67	4Q67	2Q68	3Q68	
ST	66	N/A	N/A	66	STA	N/A	1	ST	2Q67	2Q67	3Q67	4Q67	
e. 50 GPM Filter/Separator, Optimum Lightweight Design													
R&D Accept	65	4	6	66	ERDL	N/A	1	R&D Accept	4Q65	4Q65	1Q66	3Q66	3
ET	65	N/A	N/A	66	GETA	N/A	1	ET	2Q66	2Q66	4Q66	1Q67	
ST	65	N/A	N/A	66	STD	N/A	1	ST	3Q66	4Q66	2Q67	3Q67	
ST	65	N/A	N/A	66	STA	N/A	1	ST	2Q66	2Q66	3Q66	4Q66	

1. The 6 items procured include R&D acceptance, ET, and ST models
2. The 4 items procured include R&D acceptance, ET, and ST models
3. The 6 items procured include R&D acceptance, ET, and ST models

40. CMD, IND LAB, OR PROJ. MGR SUBMITTING TO AMC: U.S. Army Mobility Equipment Ctr | DATE PREPARED: 15 October 1965

FY 67-68 PROGRAM DATA SHEET

PROJECT OR TASK NO.: 1M643324D59209

PROJECT OR TASK TITLE: Fuels Decontamination Equipment

41. PRESENT STATUS AND PLANNED ACTION FY66: Status and planned action, by item as follows:

a. Filter/Separator Research. Studies are underway, both by contract and in-house, to obtain information on the physical phenomena which control and influence micronic solids filtration and finely dispersed water coalescence. During FY65, contract studies included influence of surface energy on effective coalescence and filtration; effects of surfactant type corrosion inhibitors on filtration and coalescence; inhibitor migration rates; and development of procedures for determining quantity and type fibers found in fuels. In-house studies included effects of surface active agents; coalescing investigations with high speed photography and magnification; influence of in-vessel velocities; study of potential element materials. During FY66, similar in-house studies will be pursued, and further surface energy studies will be continued under contract.

b. 350 GPM Filter/Separator, Optimum Lightweight Design. In FY65, ED was completed, and a contract for 6 EDT, ET, ST models awarded. In FY66, the contract will be monitored, and delivery will be made in 2Q66. EDT will be completed in 3Q66. ET/ST models will be delivered to TECOM test agencies, and tests monitored.

c. High Performance Military Design Filter/Separator Element. Design information is being accumulated, based on results of in-house and contract research. These studies will continue in FY66, and a preliminary design will be evolved. Coordination will be effected with potential fabricators on production processes which may be adaptable to the proposed design.

d. 600 GPM Filter/Separator, Optimum Lightweight Design. ED will be initiated in 2Q66 and completed in 3Q66. A contract for EDT, ET, ST models will be awarded in 3Q66, with delivery scheduled for 4Q66.

e. 50 GPM Filter/Separator, Optimum Lightweight Design. ED was completed and ETD, ET, and ST models procured. EDT was completed and draft technical report prepared. Preliminary ET/ST plan was prepared and coordination effected with TECOM. During FY 66, ET/ST will be conducted at Fort Lee Yuma, and Alaska test stations.

Contracts

Title/Purpose	Contractor	Estimated Cost
Filter/Separator Research	Ethyl Corporation	$40,000
600 GPM Op Lt Wt F/S	Unknown	21,000

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R&D

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3 REPORT TITLE

DESIGN, DEVELOPMENT, TEST, AND EVALUATION OF A 50-GPM OPTIMUM LIGHTWEIGHT FILTER/SEPARATOR

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)
Final July 1964 to October 1965

5 AUTHOR(S) (Last name, first name, initial)

Garlepy, George A.

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13 ABSTRACT

This report covers design, development, test, and evaluation of a 50-gpm optimum, lightweight filter/separator for primary application with 50-gpm standard military bulk transfer pumps.

A preliminary design was prepared and a contract was awarded for fabrication of a prototype model. Test and evaluation of this unit indicated the preliminary design was satisfactory. Therefore, six developmental test models were procured from Bowser-Briggs Filtration Division, Cookeville, Tenn., and subjected to the comprehensive evaluations necessary to determine conformance to the water- and solids-removal performance requirements of Mil Spec MIL-F-8901A. In addition, rail impact and rough handling tests were conducted. The report concludes: a. The 50-gpm optimum lightweight filter/separator, when tested under conditions specified in 8901A, meets all established water- and solids-removal performance requirements. b. All requirements of the Small Development Requirement are met except the requirement for incorporation of "Go No-Go" device. An exception is taken because it is concluded that the stated requirement is unrealistic, and that it is an unnecessary refinement which would increase the size, weight, and cost of the filter/separator. c. The filter/separator is suitable for integrated engineering and service tests.

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UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Filter/Separators, Filters, Coalescer, Pressure Vessel, Fuels Decontamination						

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